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Review of Studies of Tuna Food in the Atlantic Ocean

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CONTENTS

	Page
Introduction	1
Methods used for evaluation of stomach contents	2
Numerical method	2
Percentage frequency-of-occurrence method	2
Volumetric, or weight, method	2
"Points" method	2
Comments on methods used	2
Results of studies	3
Food organisms	3
Tunas as "collectors" of marine organisms	4
Feeding habits	4
Food in relation to species and size of tunas	4
Seasonal and diurnal variation in tuna food and feeding	5
Literature cited	6
Appendix	9

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ABSTRACT

Published and unpublished reports are reviewed and methods used to evaluate the data are discussed. A description is presented of the food of seven Atlantic tunas of commercial importance: little tuna (Euthynnus alletteratus), skipjack tuna (Katsuwonus pelamis), yellowfin tuna (Thunnus albacares), blackfin tuna (T. atlanticus), the bluefin tuna complex (T. thynnus thynnus and T. maccoyii), bigeye tuna (T. obesus), and albacore (T. alalunga). Their food consists mainly of pelagic fish (mostly juveniles, some larvae and adults), crustaceans (mostly macrozooplankton), and mollusks (chiefly cephalopods). The greatest number of food items are fish taxa (331), followed by crustaceans (111) and mollusks (74). Prey organisms are listed alphabetically, according to the tuna species. The food consumed by the species of tuna was generally similar. Differences in food between the juvenile and adult bluefin tuna were pronounced; juveniles fed largely on crustaceans whereas adults fed primarily on fishes. Seasonal differences were noted in the composition of the food of skipjack and yellowfin tunas in African waters.

INTRODUCTION

A thorough knowledge of food and feeding of unas is important to an understanding of regional and local aggregations of tunas and their ehavior (Reintjes and King, 1953; King and kehara, 1956; Alverson, 1963b).

Interest in the food of Atlantic tunas was videnced as early as the second half of the 9th century (De Monaco, 1888). French researchers have continued their interest in tuna ood studies to the present time. Publications n English began in the 1920's and are continuing. Contributions by Soviet, Spanish, Portuguese, and Yugoslavian authors were published in the 1960's.

The present paper reviews published and npublished reports on the food of tunas in the tlantic Ocean. Some of the papers consider eeding and food in detail; others mention them nly incidentally. I do not summarize each aper individually in this review but discuss oints of interest to a fishery biologist.

I divided the reports that were reviewed into ix categories (number of reports in parentheses): descriptive publications (9), notes (9), eports on data (9), reviews (1), incidental apers (28), and taxonomic works (2). The categories are so designated in the bibliography. Descriptive papers in general contain detailed presentations and interpretations of results; notes are largely brief reports based on limited observations; reports on data refer to untreated data in tabular form; reviews contain information mostly from other papers, which is summarized and sometimes accompanied by interpretation and comment; incidental papers give information on food or feeding habits in only a casual fashion (titles may be completely unrelated to the food of tunas); and taxonomic papers treat taxonomic aspects of tuna forage in some detail.

The most important commercial species of tunas dealt with in the papers reviewed were: little tuna (Euthynnus alletteratus), skipjack tuna (Katsuwonus pelamis), yellowfin tuna (Thunnus albacares), blackfin tuna (T. atlanticus), the bluefin tuna complex (T. thynnus thynnus and T. maccoyii), bigeye tuna (T. obesus), and albacore (T. alalunga). (The synonymy of each species includes many more names than those mentioned above.) Albacore received the most attention in the papers.

The number of stomachs on which different reports were based varied widely--from one to several thousand.

Fishing gear used to capture tuna consisted of trolling lines (with artificial lures), pole and line, purse seine, longline, spears, rod and reel, and harpoons.

METHODS USED FOR EVALUATION OF STOMACH CONTENTS

It seems appropriate to review briefly the various methods of evaluating food components that have been used in studies of the stomach contents of fishes, birds, mammals, and other animals. The four most common methods are discussed here and comments are made on their advantages and disadvantages.

Numerical Method

The numerical method is based on counts of the food items present; each item is evaluated as a percentage of the total number of all food items. The chief disadvantage in this method is that the size of forage organisms is not considered. Small organisms such as megalopa stages, for example, which occur in tuna stomachs in large numbers, often rank higher in apparent importance than do fishes or other large forage organisms. The method places undue emphasis on organisms with resistant parts--crustaceans, shelled mollusks, and scaled fishes--and thus may give a distorted picture of food components. Also, it is difficult and time-consuming to count accurately the many fragmented organisms found in stomachs, and numerous macroplanktonic organisms must be either counted or estimated from subsamples.

Percentage Frequency-of-Occurrence Method

The number of fish that have ingested a particular food organism is calculated as a percentage of the total number of fish examined. The method has the same disadvantages as the previous one: the number and size of organisms are not considered, small organisms usually outnumber large ones, and large organisms lose their importance. Like the preceding method, this procedure is primarily useful in evaluating organisms within a similar size range. The method also allows rough estimates of availability of food organisms and selectivity by predators.

Volumetric, or Weight, Method

The displacement volume or the weight of each food item is expressed as a percentage of the total volume or weight of the stomach contents. This method probably depicts most reliably the relative importance of various food items.

The volumetric method can be used in various ways. Two of these--the "aggregate-total-volume" and "average-percentage" procedures--were described by Martin, Gensch, and Brown (1946). In the first version, the percentage of each kind of food is obtained by dividing total food of each kind by total volume of the stomach contents of all fish; the volume of food from each stomach influences the final result in direct proportion to that volume. The method accurately reflects the volumetric importance of a particular food organism regardless of how many or how few other organisms are present. In the "average-percentage" version, equivalents are calculated for each item of food, and each stomach is taken as 100 percent, regardless of the volume of its contents; variation in total volume of food does not influence the results.

In his study of the food of the smallmouth bass (Micropterus dolomieui), Tester (1932) combined the volumetric and the frequency-of-occurrence methods for a graphic representation of the food items. Welsh (1949) used an average percentage rating obtained by averaging (1) the percentage of the total food volume contributed by the individual food item (indicating food value), (2) the percentage of total number of individual animals found in stomachs (indicating abundance), and (3) the percentage of the total stomachs in which organisms were found (indicating availability). When Welsh's method is used, the final figure appears to be a combination of different terms, but it may serve as a simplified and useful index.

"Points" Method

Points are assigned to food items, to the total volumes, and to the "degree of fullness" of each stomach. Assuming that the organisms are of equal size (or allowing for size), the investigator assigns the greatest number of points to the most easily digested organisms. The chief disadvantage in this method is the difficulty of establishing or maintaining standards on which to base designation of points throughout extensive surveys.

Comments on Methods Used

In most reports classified in the present paper as notes, reviews, incidental publications, and reports on data, evaluation of stomach contents was qualitative; information consisted of lists of forage organisms, accompanied by general comments. Examples are: De Monaco, 1888; Chevreux, 1893; Grandbesançon, 1910; Joubin and Roule, 1918a, 1918b; Le Danois, 1921; Nichols, 1922; De Buen, 1927; Legendre, 1932, 1933; Longley and Hildebrand, 1941; Priol, 1944; Le Gall, 1949; Postel, 1950, 1954; Bigelow and Schroeder, 1953; Rivas, 1954; Postel, 1955b; Anderson, Gehringer, and Cohen, 1956a, 1956b; Anderson and Gehringer, 1957a, 1957b, 1958a, 1958b, 1959a, 1959b, 1959c; Krumholz, 1959; De Sylva and Rathjen, 1961; Klawe, 1961; Alverson, 1963a; Postel, 1964; Zharov, Zherebenkov, Kadil'nikov, and Kuznetsov, 1964; Da Cruz, 1965; Zharov, 1966; Bogdanov, Korzhova,

Kornilov, Leonova, Liubimova, Obvintsev, Prosvirov, Sal'nikov, Terekhov, and Khromov, 1967; Sokolov, 1967a, 1967b.

The numerical method (Legendre, 1934; Bouxin and Legendre, 1936; Crane, 1936; Legendre, 1940; Carlson, 1952; Morović, 1961) and the volumetric method (Postel, 1963; Randall, 1967) were used in relatively few studies.

In the more detailed papers, usually one of the number methods (the numerical or the percentage method) was combined with the volumetric method.

In a study of blackfin and yellowfin tunas near Bermuda and the West Indies, Beebe (1936) used a number method in which he listed the number of stomachs containing each particular food item--sometimes he listed each food item in each fish by number and sometimes he used percentages in summations of broader categories, such as fishes and crustaceans.

Various combinations of frequency-of-occurrence and volumetric, or weight, methods have been used by several authors. Bane (1965) evaluated the forage organisms of blackfin tuna in the waters of Puerto Rico. Postel (1955a) evaluated the food of Neothunnus albacora (=Thunnus albacares) in the eastern tropical Atlantic. De Jager, Nepgen, and Van Wyk (1963) reported on food of tuna from the west coast of South Africa. Oren, Ben-Tuvia, and Gottlieb (1959) described food of T. thynnus, E. alletteratus, and T. alalunga from the eastern Mediterranean. Penrith (1963) studied the food of several species of tuna off the Cape of South Africa. Sund and Richards (1967) showed the distribution of forage organisms in the Gulf of Guinea for yellowfin and skipjack tunas for two different seasons; and Suarez-Caabro and Duarte-Bello (1961) evaluated the forage organisms of skipjack and blackfin tunas in Cuban waters.

Soviet scientists (Zharov, 1965; Sokolov, 1967b) often applied the points method (using an arbitrary scale) to measure the degree of fullness of tuna stomachs.

RESULTS OF STUDIES

The information in the reports reviewed was divided into several major topics: food organisms; tunas as collectors of marine organisms; tuna feeding habits; food in relation to species and size of tunas; and seasonal and diurnal variations in tuna food and feeding habits.

Food Organisms

I examined the combined data in the reviewed papers from several points of view. It did not appear that a quantitative treatment of the data in terms of areal and temporal distribution would be particularly worthwhile, since many of the original data were not quantitative.

Comparison of tuna prey in the stomachs of fishes caught by various types of gear can be of considerable value in studies of food selectivity (Blackburn, in press), but data in the reviewed papers were insufficient for such a purpose. My compilation is therefore restricted to a taxonomic list of the food items and a record of their occurrence.

About 500 different forms were identified in the tuna stomachs. Fishes were represented by the greatest number of identified kinds (331), crustaceans were second (111), and mollusks were third (74). These numbers should not be compared, since many organisms were identified only to genus or to family. The list of identified taxa may reflect the rates of digestion--the axial skeletons and scales of fishes and the exoskeletons of crustaceans are less subject to damage by digestive processes (and therefore easier to identify) than are the remains of fleshier organisms. Fewer specimens of mollusks were identified than fishes and crustaceans; most of the mollusks were cephalopods, whose identifying external characters are the first to be destroyed by the digestive process. The list of identified taxa also suggests that taxonomic work done on fishes was more extensive than that on the other two groups.

Although most of the studies were qualitative, a general pattern of feeding was evident for all the species of tuna. Taxonomically, food consisted mainly of fishes (63 percent of the total taxa), crustaceans (21 percent), and mollusks (14 percent). Tunicates (2 percent) were present but were of minor importance. Tuna forage organisms (as identified in the original publications) and the species of tunas in which they were found are listed in the Appendix. Fishes are listed alphabetically; invertebrates also are listed alphabetically but are grouped under broad categories.

Further considerations of the three main categories of tuna food revealed that the fishes eaten by tunas consisted chiefly of pelagic juveniles and adults, but also included larval forms and (occasionally) benthic fishes. Crustaceans were largely macrozooplankton (a great variety of larval decapods and stomatopods, and mostly adult hyperiid amphipods, isopods, copepods, ostracods, euphausiids, and mysids), and some micronekton (principally shrimp). Mollusks were mostly cephalopods (principally squid), but heteropods and pteropods were also prominent.

A practical aspect of studies of food organisms is the definition of a relation between the areas of food abundance (or areas of high biological productivity) and tuna abundance. Although the food chain in the ocean has been studied to some extent (mostly the relation between primary and secondary producers and large carnivores), data from the Atlantic

Ocean are scarce. The only reference to a relation between areas of primary productivity and abundance of tunas was found in recent Soviet scientific publications. Soviet investigators who linked the distribution of tuna with areas of high biological productivity were: Zharov et al., 1964; Zharov, 1965, 1966, 1967; Bogdanov et al., 1967; and Sokolov, 1967a, 1967b.

Alverson's (1960, 1963b) studies have shown that although the presence of an adequate stock of tuna food in the eastern tropical Pacific did not necessarily ensure the presence of tunas, chances of finding the fish were far greater in areas with abundant food than in food-impoverished waters. Furthermore, according to Blackburn (in press), the correlation between occurrence of tunas and their prey in the eastern tropical Pacific was closer than that between tunas and the organisms (phytoplankton and zooplankton) on which tunas do not prey.

The papers reviewed emphasize the need for additional studies of tuna food and feeding in the Atlantic. I believe this need for broader study must be met through an accumulation of data collected under contemporaneous long-term programs that seek to measure zooplankton, micronekton (tuna prey primarily), large carnivores, and oceanographic conditions.

Tunas as "Collectors" of Marine Organisms

Tunas are often excellent collectors of marine species. Numerous organisms described in the literature for the first time were taken from tuna stomachs. Collections from the stomach contents of Germo alalunga (=T. alalunga) provided the basis for descriptions of the fauna of the Gulf of Gascony by Bouxin and Legendre (1936) and Legendre (1934, 1940). These authors examined 24,293 prey organisms and identified 106 taxa from stomachs of T. alalunga caught in June, July, August, and September over 4 years (1929-32). Totals were: invertebrates 68 taxa, 70 percent of the total number of food organisms; crustaceans 33 taxa, 61 percent; and cephalopods 24 taxa, 9 percent. Of the crustaceans, 57 percent were amphipods. Brachyscellus crusculum contributed 48 percent of the total number of crustaceans, and Nematoscelis megalops 24 percent. The 38 taxa of identified fish made up 29 percent of the total organisms; 57 percent of the fish were Maurolicus muelleri.

Until Penrith's (1963) survey, Oreosoma atlanticum and Tetragonurus cuvieri were rare in museum collections; his Lestidium sp. and Taractes sp. represented the first records of these genera from South African waters; and Centropholoides falcatus was known from the type species only. The presence of these species in tuna stomachs suggested to Penrith that the fish might not be as rare as they were thought to be, but that their apparent rarity might be linked to existing inadequate methods for catching midwater organisms.

Russell (1960), used stomach contents of T. albacares to construct a taxonomic key to North Atlantic heteropods.

Chevreux (1893) described certain hyperiid amphipods on the basis of stomach contents of albacore caught between France and the Azores.

Collections of juvenile tunas are valuable aids in determining the location of the nursery areas of different species. Klawe (1961) reported juvenile T. atlanticus and Euthynnus alletteratus, Scomberomorus sp. and Katsuwonus pelamis in stomachs of K. pelamis and E. alletteratus in his studies of young scombrids from the waters between Cape Hatteras and the Bahama Islands.

Feeding Habits

Most of the publications reviewed indicated that tunas are indiscriminate pelagic feeders; some of the authors surmised that the fish also feed near the bottom. Beebe (1936) stated that yellowfin and blackfin tunas feed near the bottom at all times. Bane (1965) found that goatfishes, squirrelfishes, triggerfishes, surgeonfishes, and jacks were the most numerous fishes in the stomachs of blackfin tunas collected near Puerto Rico; most of the food fish were small (5-7 cm. long) and were common in nearby reefs and rocky areas. Bane also found invertebrates in tuna stomachs, among which were shrimp, squid, larval stomatopods, small octopi, lobster and crab larvae, and gastropod shells. The presence of benthic crustaceans and cephalopods in the stomachs of bluefin tuna collected near islands in the Adriatic also suggests that tuna sometimes feed near the bottom (Morović, 1961). Da Cruz (1965) noted large numbers of small Balistidae in the stomachs of blackfin tunas and stated that blackfin tunas often must feed near the bottom because small Balistidae are usually found on coral bottoms.

Marchal (1959), who studied the food of Neothunnus albacora (=T. albacares) in the Gulf of Guinea, divided the forage organisms into pelagic, bathypelagic, and coastal species.

Food in Relation to Species and Size of Tunas

In one of the more comprehensive studies of food of several species of tuna, Penrith (1963) showed important interspecific differences in feeding habits of tunas off the Cape of Good Hope, although he did not discuss food in relation to area or season of capture, or size of tuna. He found that T. alalunga, T. albacares, and T. obesus fed mainly on fish, cephalopods, and shrimp. T. alalunga consumed a wide variety of fishes and large quantities of macroplankton. T. albacares fed mainly on large surface organisms, but took macroplankton

(megalopae) when it was abundant locally. T. obesus fed mostly on large deep-sea forms. None of the tuna species seemed to compete with each other for food.

Zharov et al. (1964), who reviewed the tuna fishery in the Atlantic Ocean, observed interspecific differences in feeding of tunas. Skipjack tuna fed on sardines, juvenile fish, squid and other cephalopods, and small crustaceans; yellowfin tuna fed on a variety of organisms, from large plankton to fish; and little tuna fed on relatively large fish, mainly sardine and mackerel.

Intraspecific differences in food composition were noted. In the Mediterranean Sea, food of adult bluefin tuna differed from that of the young. Young bluefin tuna ate mostly small crustaceans (60 percent), fish (20 percent), mollusks (19 percent), and tunicates (1 percent); most of the fish were larvae and juvenile sardines and anchovies (Oren, Ben-Tuvia, and Gottlieb, 1959). Sokolov (1967b) reported that adult bluefin tuna fed mainly on fishes of various sizes and species (anchovy, bonito, mackerel, and small skipjack tuna).

Seasonal and Diurnal Variations in Tuna Food and Feeding

Information on the seasonal aspect of the food habits of tunas is given in only a few papers.

Sund and Richards (1967) found little geographical variation among tuna forage species in the Gulf of Guinea, but a difference from season to season. Anchoviella guineensis was found only in stomachs of tunas taken during the "cool" season. Trichiurus sp., unidentified gonostomatids, Oxyporhamphus micropterus, Atlanta sp., Illex illecebrosus, and a species of unidentified salp were present only in samples taken during the "warm" season. The seasonal distribution of other species could not be delineated because of the large differences among samples.

Penrith (1963) reported almost no seasonal variation in food taken by tuna off the Cape of Good Hope--most species were consistently present. Funchalia woodwardi was only occasionally important to T. albacares and T. alalunga, and the larvae of Jasus lalandii and Plagusia chabrus were seasonally important to T. alalunga and T. albacares, respectively. Cephalopods were the only other important food organism with pronounced changes in seasonal availability.

Information on the diurnal intensity of feeding is very scarce in the literature on Atlantic tunas. Sokolov (1967b) stated that yellowfin tuna fed actively in the morning, slackly at midday, and intensely again in the evening. Talbot and Penrith (1963) made similar observations. Suarez-Caabro and Duarte-Bello (1961) observed no differences in the food volumes between morning and afternoon.

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Appendix Table 1.--Food found in stomachs of seven species of tuna from the Atlantic Ocean

FOOD ITEM	SPECIES OF TUNA						
	Euthynnus alletteratus	Katsuwonus pelamis	Thunnus albacares	Thunnus atlanticus	Thunnus thynnus	Thunnus obesus	Thunnus alalunga
FISHES							
Abalistes stellaris (Bloch and Schneider)	--	--	--	--	--	--	X
Ablennes hians (Valenciennes)	X	X	--	--	--	--	--
Acanthurus sp.	--	X	X	X	--	--	X
Acanthurus chirurgus (Bloch)	X	X	--	X	--	--	--
Acanthurus coeruleus Bloch and Schneider	--	X	X	--	--	--	--
Acanthurus hepatus (Linnaeus)	X	--	--	--	--	--	--
Acanthurus monroviae Steindachner	--	--	X	--	--	--	X
Alepisaurus sp.	--	--	X	X	--	--	X
Alepisaurus ferox Lowe	--	--	X	--	--	X	X
Allaneta harringtonensis (Goode)	X	--	--	--	--	--	--
Alutera sp.	--	--	X	--	--	--	--
Alutera monoceros (Linnaeus)	--	--	X	--	--	--	--
Alutera scripta (Osbeck)	--	--	X	--	--	--	--
Alutera heudelotii Hollard	--	--	X	--	--	--	--
Ammodytes sp.	X	--	--	--	--	--	--
Anchoa cubana (Poey)	X	--	--	--	--	--	--
Anchoa sp.	X	--	--	--	--	--	--
Anchoviella sp.	--	--	--	X	--	--	--
Anchoviella guineensis (Rossignol and Blache)	--	X	X	--	--	--	--
Anoplogaster cornutus (Cuvier and Valenciennes)	--	--	--	X	--	--	--
Anotopterus pharao Zugmayer	--	--	--	--	--	--	X
Antennarius sp.	--	--	X	--	--	--	--
Anthias sacer Lowe	X	--	--	--	X	--	X
Antigonia sp.	--	--	X	--	--	--	X
Antigonia combatia Berry and Rathjen	--	--	--	X	--	--	--
Aphanopus sp.	--	X	--	--	--	--	X
Argentina sp.	--	--	--	--	--	--	X
Argyropelecus sp.	--	--	--	--	--	--	X
Argyropelecus aculeatus Cuvier and Valenciennes	--	--	--	X	--	--	--
Argyropelecus olfersi (Cuvier)	--	--	--	--	--	--	X
Ariomma ledanoisi (Belloc)	--	--	--	--	--	--	X
Arnoglossus sp.	--	--	X	--	--	--	--
Arnoglossus imperialis Rafinesque	--	--	--	--	--	--	X
Atherinidae	X	X	--	--	--	--	--
Atherinomorus stipes (Müller and Troschel)	--	X	X	--	--	--	--
Aulopus sp.	X	--	--	--	--	--	--
Auxis sp.	--	--	X	--	--	--	--
Auxis thazard (Lacépède)	X	--	X	--	--	--	X
Avocettina infans (Günther)	--	--	--	X	--	--	--
Balistidae	X	X	X	X	--	--	X

Appendix Table 1.--Food found in stomachs of seven species of tuna from the Atlantic Ocean--Continued

FOOD ITEM	SPECIES OF TUNA						
	Euthynnus alletteratus	Katsuwonus pelamis	Thunnus albacares	Thunnus atlanticus	Thunnus thynnus	Thunnus obesus	Thunnus alalunga
FISHES							
Balistes sp.	--	--	X	--	--	--	--
Balistes forcipatus Gmelin	--	--	X	--	--	--	X
Bathylagus microcephalus Norman	--	--	--	--	X	--	X
Barathronus parfaiti Vaillant	--	--	--	--	--	--	X
Belonidae	--	--	X	--	--	--	--
Belone belone (Linnaeus)	--	--	--	--	--	--	X
Benthodesmus atlanticus Goode and Bean	--	--	--	X	--	--	--
Berycoidea	--	--	X	--	--	--	--
Blennius ocellaris Linnaeus	--	--	--	--	--	--	X
Boops vulgaris Bowdich	--	--	--	--	--	--	X
Bothidae	--	--	--	--	--	--	X
Box boops Vinciguerra	X	--	--	--	--	--	--
Brama sp.	--	--	--	--	X	--	--
Brama rayi (Bloch)	--	--	X	X	X	X	X
Bramidae	--	X	X	X	--	X	X
Brevoortia tyrannus (Latrobe)	--	--	--	X	--	--	--
Brotulidae	--	X	X	--	--	--	--
Cantherines pullus (Ranzani)	--	X	X	--	--	--	--
Canthidermis sufflamen (Mitchill)	--	--	X	X	--	--	--
Canthigaster rostratus (Bloch)	--	--	X	--	--	--	X
Capros aper (Linnaeus)	--	--	--	--	--	--	X
Carangidae	X	X	X	X	--	--	--
Caranx sp.	X	--	X	X	--	--	--
Caranx bartholomaei Cuvier	--	--	X	--	--	--	--
Caranx crysos (Mitchill)	X	X	X	--	--	--	--
Caranx hippos (Linnaeus)	--	--	--	X	--	--	X
Caranx latus Agassiz	X	X	X	--	--	--	--
Caranx rhonchus Geoffroy St.-Hilaire	--	--	--	--	--	--	X
Caranx ruber (Bloch)	--	X	X	--	--	--	--
Caranx trachurus Cuvier	--	--	--	--	--	--	X
Centropholoides falcatus (Barnard)	--	--	X	--	X	X	X
Ceratioidei	--	--	--	--	--	--	X
Ceratoscopelus townsendi (Eigenmann and Eigenmann)	--	--	--	--	--	--	X
Chaetodontidae	--	--	--	--	--	--	X
Chaetodon marleyi Regan	--	--	--	--	--	--	X
Chaetodon sedentarius Poey	--	--	--	X	--	--	--
Chaetodon striatus Linnaeus	--	--	--	X	--	--	--
Champsodon sp.	--	--	--	--	--	--	X
Chauliodus sloani Schneider	--	--	--	--	--	--	X
Chiasmodontidae	--	--	X	X	--	--	X
Chlorophthalmus agassizi Bonaparte	--	--	--	--	--	--	X
Chlorophthalmus atlanticus Poll	--	--	X	--	--	--	--
Chloroscombrus sp.	--	--	X	--	--	--	--
Clinidae	--	X	--	--	--	--	--
Clupea finta Cuvier	--	--	--	--	X	--	--

Appendix Table 1.--Food found in stomachs of seven species of tuna from the Atlantic Ocean--Continued

FOOD ITEM	SPECIES OF TUNA						
	Euthynnus alletteratus	Katsuwonus pelamis	Thunnus albacares	Thunnus atlanticus	Thunnus thynnus	Thunnus obesus	Thunnus alalunga
FISHES							
Clupea sprattus Poggi	--	--	--	X	--	--	--
Clupeidae	X	--	--	--	--	--	--
Collybus sp.	--	--	--	--	--	--	X
Conger conger (Linnaeus)	--	--	--	--	--	--	X
Conger vulgaris (leptocephala) Günther	--	--	--	--	--	--	X
Congermuranea impressa (Poey)	X	--	--	--	--	--	--
Coryphaena hippurus Linnaeus	X	--	X	--	--	--	X
Cubiceps gracilis (Lowe)	--	--	X	--	--	--	X
Cyclichthys orbicularis Kaup	--	--	X	--	--	--	--
Cypselurus sp.	X	--	X	--	--	--	--
Cypselurus furcatus (Mitchill)	--	--	--	--	--	--	X
Cypselurus heterurus (Rafinesque)	--	X	--	--	--	--	--
Cypselurus lineatus (Valenciennes)	--	--	--	--	--	--	X
Dactyloptena orientalis (Cuvier)	--	--	--	--	--	--	X
Dactylopteridae	--	--	X	--	--	--	X
Dactylopterus volitans (Linnaeus)	--	X	X	X	--	--	--
Decapterus macarellus (Cuvier)	--	--	X	X	--	--	--
Decapterus punctatus (Agassiz)	X	X	X	X	--	--	X
Decapterus ronchus (Geoffroy St.-Hilaire)	X	--	--	--	--	--	--
Diagramma mediterraneum (Guichenot)	--	--	--	--	--	--	X
Diaphus sp.	--	--	--	--	X	X	X
Diaphus effulgens (Goode and Bean)	--	--	--	X	--	--	X
Diaphus gemellarii (Cocco)	--	--	--	--	--	--	X
Diaphus lütkeni (Brauer)	--	--	--	--	--	--	X
Diaphus rafinesquii (Cocco)	--	--	--	X	--	--	--
Diaphus theta Eigenmann and Eigenmann	--	--	--	--	--	--	X
Diodon sp.	--	X	X	X	--	--	--
Diodon holacanthus Linnaeus	--	X	X	--	--	--	--
Diodon hystrix Linnaeus	--	--	--	--	X	--	--
Diplodus sargus (Linnaeus)	--	--	--	--	--	--	X
Diretmus argenteus Johnson	--	--	--	--	X	--	--
Engraulidae	X	--	--	--	--	--	--
Engraulis sp.	X	--	X	--	--	--	--
Engraulis encrasicholus (Linnaeus)	X	--	--	--	X	--	X
Engraulis hepsetus Linnaeus	--	X	--	--	--	--	--
Engraulis japonicus (Hottuyn)	--	--	X	--	X	X	--
Entelurus aequoreus Linnaeus	--	--	--	--	--	--	X
Epinnula orientalis Gilchrist and Von Bonde	--	--	--	X	--	--	--
Etrumeus teres (De Kay)	X	X	--	X	X	--	--
Eucinostomus pseudogula Poey	--	X	X	--	--	--	--
Euthynnus alletteratus (Rafinesque)	X	--	X	--	--	--	X
Exocoetidae	X	X	X	--	--	--	X
Exocoetus sp.	X	--	--	--	--	--	--
Exonautes rubescens (Rafinesque)	--	--	--	X	--	--	--

Appendix Table 1.--Food found in stomachs of seven species of tuna from the Atlantic Ocean--Continued

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	Euthynnus alletteratus	Katsuwonus pelamis	Thunnus albacares	Thunnus atlanticus	Thunnus thynnus	Thunnus obesus	Thunnus alalunga
FISHES							
Fistularia serrata Cuvier	--	--	--	X	--	--	--
Fistularia tabacaria Linnaeus	X	--	--	X	--	--	--
Fistularia villosa Klunzinger	--	--	X	--	--	--	--
Fodiator acutus (Valenciennes)	X	--	X	--	--	--	--
Gadidae	X	--	--	--	--	--	--
Galeoides polydactylus (Vahl)	X	--	--	--	--	--	--
Gempylidae	--	X	X	X	--	--	X
Gempylus serpens Cuvier	--	X	X	--	--	--	X
Gephyroberyx darwini (Johnson)	--	X	--	--	--	--	--
Gerridae	--	X	--	--	--	--	--
Gerres cinereus (Walbaum)	--	X	--	--	--	--	--
Gonorynchus gonorynchus (Linnaeus)	--	--	X	--	--	--	--
Gonostoma sp.	--	--	X	--	--	--	--
Gonostomatidae	--	--	X	--	--	--	--
Haemulon flavolineatum (Desmarest)	X	--	--	--	--	--	--
Halieutea fitzsimonsi (Gilchrist and Thompson)	--	--	--	--	--	--	X
Harengula sp.	--	--	--	--	X	--	--
Helicolenus dactylopterus (De la Roche)	--	--	--	--	--	--	X
Helicolenus maculatus Cuvier	--	--	--	--	X	X	X
Helicolenus porcus (Linnaeus)	X	--	--	--	X	--	X
Hemipteronotus sp.	--	--	--	X	--	--	--
Hemipteronotus noracula (Linnaeus)	X	--	--	--	--	--	--
Hemiramphidae	X	X	X	--	--	--	--
Hemiramphus sp.	X	X	--	X	--	--	--
Hemiramphus balao LeSueur	--	X	--	--	--	--	--
Heterosomata larvae	--	--	--	X	--	--	X
Hippocampus sp.	X	--	X	--	X	--	--
Hippocampus brevirostris Valenciennes	--	--	--	--	X	--	--
Hippocampus erectus Perry	--	--	--	X	--	--	--
Holocentridae	--	X	--	X	--	--	--
Holocentrus Gronow	--	X	X	--	--	--	--
Holocentrus ascensionis (Osbeck)	X	X	X	X	--	--	--
Holocentrus rufus (Walbaum)	X	X	X	--	--	--	--
Holocentrus vexillarius (Poey)	X	--	--	X	--	--	--
Hyporhamphus sp.	X	X	--	--	--	--	X
Hyporhamphus unifasciatus (Ranzani)	--	--	X	--	--	--	--
Jenkinsia sp.	X	--	--	X	--	--	--
Katsuwonus pelamis (Linnaeus)	X	X	--	X	--	--	X
Lactophrys sp.	--	--	--	X	--	--	--
Lagocephalus sp.	--	--	--	--	--	--	X
Lagocephalus laevigatus (Linnaeus)	--	--	X	--	--	--	--
Lampadena chavesii Collett	--	--	--	--	X	X	--
Lampanyctodes hectoris Günther	--	--	X	--	X	X	X
Lampanyctus sp.	--	--	--	--	--	X	X

Appendix Table 1.--Food found in stomachs of seven species of tuna from the Atlantic Ocean--Continued

FOOD ITEM	SPECIES OF TUNA						
	Euthynnus alletteratus	Katsuwonus pelamis	Thunnus albacares	Thunnus atlanticus	Thunnus thynnus	Thunnus obesus	Thunnus alalunga
FISHES							
Lampanyctus alatus (postlarva) Goode and Bean --now Lampanyctus pusillus (Johnson)	--	--	--	--	--	--	X
Lampanyctus crocodilus (Risso)	--	--	--	--	--	--	X
Lampanyctus intricarius Taaning	--	--	--	--	--	--	X
Lampanyctus maderensis (Lowe)	--	--	--	--	--	--	X
Lampanyctus margaritiferus (Goode and Bean)	--	--	--	--	--	--	X
Lamputa umgazi Smith	--	--	--	--	--	--	X
Laptostomais sp.	--	X	--	--	--	--	--
Lepidopus sp.	--	--	X	--	--	--	X
Lepidopus caudatus (Euphrasen)	--	--	X	--	X	X	X
Lepidotrigla sp.	--	--	X	--	--	--	--
Leptocephalus (Anguilliformes-larvae)	X	--	X	X	--	--	--
Lestidium sp.	--	--	X	--	--	X	X
Lichia glauca (Linnaeus) (Probably: Trachinotus glauca (Linnaeus))	--	--	--	--	--	--	X
Liosaccus cutaneus (Günther)	--	--	--	--	--	--	X
Lophiidae	--	--	--	--	--	--	X
Maurolicus sp.	--	--	--	X	--	--	X
Maurolicus muelleri (Gmelin)	--	--	X	--	X	--	X
Melanostomiatidae	--	--	--	X	--	--	--
Merluccius bilinearis (Mitchill)	--	--	--	--	X	--	--
Merluccius capensis Gastlenau	--	--	X	--	X	X	X
Merluccius merluccius (Linnaeus)	--	--	--	--	--	--	X
Micropteryx chrysurus (Linnaeus) (Chloroscombrus chrysurus)	--	--	--	--	--	--	X
Molidae	--	--	X	X	--	--	X
Monacanthus sp.	--	--	--	X	--	--	--
Monacanthus ciliatus (Mitchill)	X	--	X	X	--	--	--
Monacanthus hispidus (Linnaeus)	--	--	X	X	--	--	--
Monacanthus tuckeri Bean	--	--	--	X	--	--	--
Mullidae	--	--	--	X	--	--	X
Mulloidichthys martinicus (Cuvier)	X	--	--	--	--	--	--
Mullus barbatus Linnaeus	--	--	--	--	--	--	X
Myctophidae	--	--	--	--	X	--	X
Myctophum coccoi (Cocco)	--	--	X	--	X	X	X
Myctophum sp.	X	--	X	--	--	--	X
Myctophum humboldti (Risso)	--	--	X	--	X	X	X
Myctophum hygomii (Lütken)	--	--	--	X	--	--	--
Myctophum punctatum Rafinesque	--	--	--	--	--	--	X
Myctophum tisso (Cocco)	--	--	--	--	--	--	X
Naucrates ductor (Linnaeus)	--	--	X	--	--	--	X

Appendix Table 1.--Food found in stomachs of seven species of tuna from the Atlantic Ocean--Continued

FOOD ITEM	SPECIES OF TUNA						
	Euthynnus alletteratus	Katsuwonus pelamis	Thunnus albacares	Thunnus atlanticus	Thunnus thynnus	Thunnus obesus	Thunnus alalunga
FISHES							
Nemichthys scolopaceus Richardson	--	--	--	--	--	--	X
Nesiarchus nasutus Johnson	--	--	--	X	--	--	--
Nesiarchus sp.	--	--	X	--	--	--	--
Notolepis rissoi kroyers (Lütken)	--	--	--	--	--	--	X
Ogcocephalidae	--	--	--	X	--	--	--
Oligoplites saurus (Bloch and Schneider)	--	X	--	--	--	--	--
Omosudis lowii Günther	--	--	--	X	--	--	X
Onos mediterraneus (Linnaeus)	--	--	--	--	--	--	X
Onos vulgaris Yarrel	--	--	--	--	--	--	X
Ophidiidae	--	--	--	X	--	--	--
Ophidion barbatum Linnaeus	--	--	X	--	--	--	--
Ophidion vassali Risso	X	--	--	--	X	--	X
Oreosoma atlanticum Cuvier and Valenciennes	--	--	X	--	X	X	X
Ostracion sp.	--	--	X	--	--	--	X
Ostracion tuberculatus Linnaeus	--	--	X	--	--	--	--
Oxyporhamphus sp.	--	--	X	--	--	--	--
Oxyporhamphus micropterus similis Bruun	--	X	X	--	--	--	--
Otophidium omostigmum (Jordan and Gilbert)	X	--	--	--	--	--	--
Pagellus sp.	X	--	--	--	--	--	--
Paralepis sp.	X	--	X	X	X	--	X
Paralepis coregonoides Risso	--	--	--	--	--	--	X
Paralepis coregonoides borealis Reinhardt	--	--	--	--	--	--	X
Paralepis pseudosphyraenoides Ege	--	--	--	--	--	--	X
Paralepis spesiosus Bellotti	X	--	--	--	X	--	X
Paralepis sphyraenoides Risso	--	--	--	--	--	--	X
Paranthias furcifer (Valenciennes)	--	--	--	X	--	--	--
Peprilus alepidotus (Linnaeus)	X	--	--	--	--	--	--
Photichthys argenteus Hutton	--	--	--	--	--	--	X
Plagyodus alepisaurus Lowe	--	--	--	--	--	--	X
Planctanthias praeopercularis Fowler	--	--	--	--	--	--	X
Pleuronectoidea	X	--	--	--	--	--	--
Polydactylus virginicus (Linnaeus)	--	X	--	X	--	--	--
Polyipnus spinosus Günther	--	--	X	--	X	X	X
Pomadasys sp.	X	--	--	--	--	--	--
Priacanthidae	--	X	--	--	--	--	--
Priacanthus sp.	--	--	X	--	--	--	X
Priacanthus cruentatus (Lacépède)	--	--	X	--	--	--	--
Priacanthus hamrur Forskal	--	--	--	--	--	--	X
Prionotus sp.	X	--	--	--	--	--	--
Pristopomatides sp.	--	--	X	--	--	--	--
Prognichthys gibbifrons (Valenciennes)	--	X	--	--	--	--	--

Appendix Table 1.--Food found in stomachs of seven species of tuna from the Atlantic Ocean--Continued

FOOD ITEM	SPECIES OF TUNA						
	Euthynnus alletteratus	Katsuwonus pelamis	Thunnus albacares	Thunnus atlanticus	Thunnus thynnus	Thunnus obesus	Thunnus alalunga
FISHES							
Psenes sp.	--	--	X	--	--	--	X
Psenes cyanophrys Cuvier	--	--	X	--	--	--	--
Pseudopentaceros richardsoni (Smith)	--	--	--	--	--	--	X
Pseudopriacanthus altus (Gill)	X	--	X	--	--	--	--
Pseudupeneus maculatus (Bloch)	X	--	--	--	--	--	--
Pseudupeneus prayensis (Cuvier)	--	--	X	--	--	--	--
Pteraclidae	--	--	--	--	--	--	X
Pteraclis sp.	--	--	X	--	--	--	--
Pterycombus goodei (Jordan)	--	X	X	--	--	--	--
Rhomboplites aurorubens (Cuvier)	--	--	--	X	--	--	--
Sardina pilchardus (Walbaum)	--	--	--	--	X	--	--
Sardinella sp.	X	X	X	--	--	--	--
Sardinella anchovia Valenciennes	X	--	X	X	--	--	--
Sardinella aurita Valenciennes	X	--	X	--	X	--	X
Sardinella eba (Cuvier and Valenciennes)	--	--	--	--	--	--	X
Sardinella rouxi Whitehead	--	--	X	--	--	--	--
Sardinops ocellata (Pappe)	--	--	X	--	X	X	X
Sargus sp.	X	--	--	--	--	--	--
Saurida parri Norman	X	--	--	--	--	--	--
Schedophilus enigmaticus Günther	--	--	--	--	--	--	X
Schedophilus medusophagus Cocco	--	--	--	--	--	--	X
Scomber sp.	X	--	--	--	--	--	--
Scomber japonicus Houttuyn	X	X	X	--	X	X	X
Scomberesox saurus (Walbaum)	--	--	X	--	X	X	X
Scomberomorus maculatus (Mitchill)	X	--	--	--	--	--	--
Scombridae	X	--	X	--	--	--	--
Selene vomer (Linnaeus)	--	--	--	X	--	--	--
Selar crumenophthalmus (Bloch)	X	--	X	X	--	--	X
Serranidae	--	X	X	X	--	--	X
Smaris sp.	X	--	--	--	--	--	--
Soleidae	--	--	--	--	--	--	X
Sparisoma flavescens (Bloch and Schneider)	X	--	--	--	--	--	--
Sphaeroides sp.	--	--	--	X	--	--	--
Sphaeroides spengleri (Bloch)	--	--	X	--	--	--	--
Sphyraena sp.	X	--	X	--	--	--	X
Sphyraena barracuda (Walbaum)	--	X	--	--	--	--	--
Spondyliosoma cantharus (Linnaeus)	--	--	--	--	--	--	X
Sternoptyx diaphana Herman	--	X	--	--	--	--	X
Stomiatidae	--	--	--	--	--	--	X
Strongylura sp.	--	--	--	X	--	--	--
Strongylura marina (Walbaum)	--	--	X	--	X	--	--
Strongylura timucu (Walbaum)	X	--	--	--	--	--	--
Sudis sp.	--	--	--	--	--	--	X
Synagrops microlepis Norman	--	--	X	--	--	--	X
Syngnathidae	--	X	X	--	--	--	--

Appendix Table 1.--Food found in stomachs of seven species of tuna from the Atlantic Ocean--Continued

FOOD ITEM	SPECIES OF TUNA						
	Euthynnus alletteratus	Katsuwonus pelamis	Thunnus albacares	Thunnus atlanticus	Thunnus thynnus	Thunnus obesus	Thunnus alalunga
FISHES							
Syngnathus sp.	--	--	X	X	X	--	--
Syngnathus dunckeri Metzelaar	--	--	--	X	--	--	--
Syngnathus springeri Herald	X	--	--	--	--	--	--
Synodontidae	X	--	X	--	--	--	--
Synodus sp.	--	X	X	--	--	--	--
Synodus synodus (Linnaeus)	--	--	--	--	--	--	X
Taractes sp.	--	--	X	--	--	--	X
Tetragonurus atlanticus Lowe	--	--	--	--	--	--	X
Tetragonurus cuvieri Risso	--	--	--	--	--	--	X
Tetraodontidae	--	--	X	X	--	--	X
Therapon sp.	--	--	--	--	--	--	X
Thunnus atlanticus (Lesson)	--	X	--	--	--	--	--
Thyrsites atun (Euphrasen)	--	X	--	--	--	--	X
Trachurus sp.	--	--	--	--	--	--	X
Trachurus trachurus (Linnaeus)	--	--	X	--	X	--	X
Trachypterus iris (Walbaum)	--	--	--	--	--	--	X
Trachurus trachurus (Linnaeus)	--	--	X	--	X	X	X
Trichiurus sp.	--	X	X	--	--	--	--
Trichiurus lepturus Linnaeus	--	X	--	--	--	--	X
Trigla gurnardus Linnaeus	--	--	--	--	--	--	X
Triglidae (Trigla sp.)	--	--	--	--	--	--	X
Tripterodon sp.	--	--	--	--	--	--	X
Tylosurus acus (Lacépède)	X	--	--	--	--	--	--
Tylosurus crocodilus Linnaeus	X	--	--	--	--	--	--
Uranoscopus sp.	--	--	X	--	--	--	--
Valenciennellus tripunctulatus (Esmark)	--	--	X	--	--	--	--
Vomer setapinnis (Mitchill)	--	--	X	--	--	--	X
Vinciguerria sp.	--	--	--	--	--	--	X
Vinciguerria sanzoi Jespersen and Taaning	--	--	--	--	--	--	X
Xanthichthys ringens (Linnaeus)	--	--	X	X	--	--	--
Xiphasia setifer Swainson	--	--	X	--	--	--	--
Yozia bicoarctata (Bleeker)	--	--	X	--	--	--	--
Zeoidei	--	--	--	--	--	--	X
Zeus sp.	--	--	X	--	--	--	--
INVERTEBRATES							
OSTRACODA:							
Conchoecia sp.	--	--	--	--	--	--	X
Ostracoda (not further identified)	--	--	--	X	--	--	--
CEPEPODA:							
Calanus finmarchicus (Gunner)	--	--	--	--	--	--	X
Copepoda (not further identified)	X	X	--	--	--	--	--
Penella exocoeti (Holten)	--	--	X	--	--	--	--
CIRRIPEDIA:							
Lepas anatifera Linnaeus	--	--	--	--	--	--	X

Appendix Table 1.--Food found in stomachs of seven species of tuna from the Atlantic Ocean--Continued

FOOD ITEM	SPECIES OF TUNA						
	Euthynnus alletteratus	Katsuwonus pelamis	Thunnus albacares	Thunnus atlanticus	Thunnus thynnus	Thunnus obesus	Thunnus alalunga
INVERTEBRATES							
MYSIDACAEA:							
Gnathophausia ingens (Dohrn)	--	--	--	X	--	--	X
ISOPODA:							
Isopoda (not further identified)	--	X	X	X	--	--	--
Idotea metallica Bosc	--	--	--	--	--	--	X
AMPHIPODA:							
Anchylomera blossevillei H. Milne Edwards	X	--	--	--	X	--	X
Amphipoda (not further identified)	--	X	X	X	--	--	X
Brachyscelus sp.	--	--	X	--	--	--	--
Brachyscelus crusculum Bate	X	--	X	--	X	--	X
Cystisoma sp.	--	--	X	--	X	--	X
Euthemisto sp.	--	--	--	--	--	--	X
Euthemisto bispinosa (Boeck) (Syn. of Parathemisto guadichaudii (Guerin))	--	--	--	--	--	--	X
Euprimno macropaus (Guerin) --now Primno macropa (Guerin)	--	--	--	X	--	--	--
Gammarus sp.	--	--	--	--	--	--	X
Hyperiidae	--	--	X	--	--	--	--
Hyperioides longipes (Chevreux)	X	--	--	--	X	--	X
Hyperia galba (Montegu)	--	--	--	--	--	--	X
Lanceola sayana Bovallius	--	--	X	--	--	--	--
Oxycephalus sp.	--	--	X	X	--	--	--
Parapronoë crustulum Claus	--	--	X	--	X	X	X
Paraphronima crassipes (Claus)	X	--	--	--	X	--	X
Parathemisto obliva (Kröyer) probably Parathemisto gracilipes (Norman)	--	--	--	--	--	--	X
Phronima sp.	--	--	X	X	--	--	--
Phronima atlantica Guérin	X	--	X	--	X	--	X
Phronima sedentaria (Forskal)	X	X	X	X	X	X	X
Phronima stebbingii (Vosseler)	X	--	--	--	X	--	X
Phrosina semilunata Risso	X	--	X	--	X	X	X
Platyscelus armatus (Claus)	--	--	X	--	X	X	X
Platyscelus ovoides (Risso)	X	--	--	--	X	--	X
Platyscelus serratulus Stebbing	--	--	--	--	--	--	X
Streetsia sp.	--	--	X	--	--	--	X
Streetsia challengeri Stebbing	--	--	--	--	--	--	X
Streetsia pronoides (Bovallius)	X	--	--	--	X	--	X
STOMATOPODA:							
Gonodactylus sp.	--	X	--	X	--	--	--
Lysiosquilla sp. (larvae)	--	X	X	X	--	--	--
Stomatopoda (not further identified)	X	X	X	X	--	--	--
Squillidae (various types of larvae)	X	X	X	X	--	--	X
Squilla sp.	--	--	X	X	--	--	--

Appendix Table 1.--Food found in stomachs of seven species of tuna from the Atlantic Ocean--Continued

FOOD ITEM	SPECIES OF TUNA						
	Euthynnus alletteratus	Katsuwonus pelamis	Thunnus albacares	Thunnus atlanticus	Thunnus thynnus	Thunnus obesus	Thunnus alalunga
INVERTEBRATES							
EUPHAUSIACEA:							
Euphausiacea (not further identified)	--	X	X	X	X	--	X
Euphausia sp.	--	--	X	--	--	--	--
Euphausia lucens Hansen	--	--	X	-	X	X	X
Meganyctiphanes norvegica (M. Sars)	--	--	--	--	--	--	X
Nematoscelis megalops G. O. Sars	--	--	--	--	--	--	X
Nematoscelis sp.	X	--	--	--	X	--	X
Nyctiphanes sp.	--	X	--	--	--	--	--
Nyctiphanes capensis Hansen	--	--	X	--	--	--	--
Nyctiphanes couchii (Bell)	--	--	X	--	--	--	--
Stylocheiron abbreviatum G.O. Sars	--	--	--	--	--	--	X
Thysanoessa sp.	X	--	--	--	X	--	X
Thysanopoda	X	--	--	--	X	--	X
DECAPODA-CRUSTACEA:							
Decapoda (not further identified)	X	X	X	X	--	--	--
PENAEIDAE:							
Aristaeomorpha foliacea (Risso)	--	--	--	--	--	--	X
Cerataspis sp. (larvae)	--	--	X	--	--	--	--
Cerataspis monstrosa Gray	--	--	X	X	--	--	--
Funchalia villosa (Bouvier)	--	--	--	X	--	--	--
Mysis stages	X	--	--	--	--	--	--
Funchalia woodwardi Johnson	--	--	X	--	X	X	X
Gennadas (Amalopenaeus) elegans S. I. Smith	--	--	--	--	--	--	X
Parapenaeus longirostris (Lucas)	X	--	X	--	--	--	--
Penaeus duorarum Burkenroad	X	--	--	--	--	--	--
Penaeidae (not further identified)	X	--	--	--	--	--	X
SERGESTIDAE:							
Sergestes sp.	--	--	--	--	--	--	X
Sergestes arcticus Krŏyer	--	--	--	--	--	--	X
Sergestes gloriosus Stebbing	--	--	--	--	--	--	X
Sergestes phorcus Faxon	--	--	--	--	--	--	X
Sergestes robustus Smith	--	--	--	--	--	--	X
Sergestes splendens Sund	--	--	--	--	X	--	--
CARIDEA:							
Acanthephyra sp.	--	--	X	--	--	--	X
Acanthephyra multispina Coutiere Syn. of A. pelagica (Risso)	--	--	--	--	--	--	X
Alpheidae (Diaphorus-larvae)	--	--	--	--	--	--	X
Alpheus ruber (larvae Anebocaris) H. Milne Edwards	--	--	--	--	--	--	X
Brachycarpus biunguiculatus (Lucas)	X	--	--	--	X	--	X
Enoplometopus dentatus Miers	--	--	--	--	--	--	X
Glyphocrangon sp.	--	--	--	--	--	--	X
Heterocarpus ensifer A. Milne Edwards	--	--	X	--	--	--	--
Hippolytidae	--	--	X	--	--	--	--

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	Euthynnus alletteratus	Katsuwonus pelamis	Thunnus albacares	Thunnus atlanticus	Thunnus thynnus	Thunnus obesus	Thunnus alalunga
INVERTEBRATES							
Icotopus amphissimus Coutiére	X	--	--	--	X	--	X
Leptochela sp.	--	X	--	X	--	--	--
Palaemonidae	--	X	--	--	--	--	--
Palaemonella sp.	--	--	X	X	--	--	--
Parapasiphae sulcatifrons Smith	--	--	--	--	--	--	X
Pasiphae sp. (?)	--	--	--	--	--	--	X
Systellaspis debilis A. Milne Edwards	--	--	--	--	--	--	X
MACRURA-REPTANTIA:							
Axius stirhynchus Leach	--	--	--	--	--	--	X
Hippa cubensis (Saussure)	--	--	--	X	--	--	--
Jasus lalandii (A. Milne Edwards)	--	--	X	--	X	X	X
Jasus parkeri Stebbing - Syn. of Projasus parkeri (Stebbing)	--	--	--	--	--	--	X
Nephrops andamanica (?) Wood-Mason	--	--	--	--	--	--	X
Palinuridae	--	X	--	--	--	--	--
Palinurus sp.	--	X	--	--	--	--	X
Palinurus regius Brito Capello	--	--	--	X	--	--	X
Palinurus vulgaris (Phyllosoma) Latreille	X	--	--	--	X	--	X
Panulirus sp.	--	--	--	X	--	--	--
Phyllosoma	--	--	X	--	--	--	--
Scyllarides sp. (nisto stage)	--	--	--	--	--	--	X
Scyllarus arctus (Linnaeus)	X	--	--	--	X	--	X
Paguridae (Glaucothöe)	--	X	X	X	--	--	--
Pagurus sp.	--	--	X	--	--	--	--
Stenopus hispidus (Olivier)	--	--	--	X	--	--	--
BRACHYURA:							
Brachyrhyncha	--	X	--	--	--	--	--
Brachyrhyncha-megalopa	--	--	X	X	X	X	X
Megalopa (Portunidae and Dromiidae)	--	--	X	--	--	--	--
Megalopa	--	X	X	X	X	X	X
Oxyrhyncha	--	X	--	X	--	--	--
Plagusia chabrus (Linnaeus)	--	--	X	--	--	--	X
Portunas sp.	--	--	--	--	X	--	--
Zoea	--	X	X	--	--	--	X
OCTOPODA:							
Allopsus mollis Verrill	--	--	--	X	--	--	--
Argonauta nodosa Solander	--	--	X	--	X	X	X
Argonauta sp.	--	--	X	--	X	X	X
Bathypolypus sponsalis P. and H. Fischer	--	--	X	--	--	--	--
Bolliattaenella (Japetella) diaphana (Hoyle)	--	--	--	--	--	--	X
Eledone cirrhosa (Lamarck)	--	--	--	--	--	--	X
Eledone moschata (Lamarck)	--	--	--	--	X	--	--
Nautilus sp.	--	X	--	--	--	--	--
Octopidae	--	X	--	X	--	--	--

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	Euthynnus alletteratus	Katsuwonus pelamis	Thunnus albacares	Thunnus atlanticus	Thunnus thynnus	Thunnus obesus	Thunnus alalunga
INVERTEBRATES							
Octopus sp.	--	X	--	X	X	--	--
Octopus burryi Voss	--	X	--	X	--	--	--
Octopus vulgaris Lamarck	--	--	X	--	--	--	X
Octopus defilippi Verany	--	--	X	--	--	--	--
Ocythoe tuberculata Rafinesque	--	--	--	--	--	--	X
Todarodes sagittatus (Lamarck)	--	--	X	--	--	--	--
Tremoctopus violaceus Delle Chiaja	--	--	--	--	--	--	X
Vitreledonella sp. (?)	--	--	--	--	--	--	X
TEUTHOIDEA:							
Abralia gilchristi Robson	--	--	X	--	X	X	X
Abralia veranyi (Ruppell)	--	X	X	--	--	--	--
Allotheuthis africana Adam	--	--	X	--	--	--	--
Brachioteuthis (Tracheloteuthis) riisei (Streenstrup)	--	--	--	--	--	--	X
Calliteuthis reversa (Verrill)	--	--	--	--	--	--	X
Chiroteuthis veranyi (Ferussac)	--	--	--	--	--	--	X
Chranchia scabra Leach	--	--	X	--	X	X	X
Ctenopteryx siculus Verany	--	--	--	--	--	--	X
Desmoteuthis hyperborea (Steenstrup)	--	--	--	--	--	--	X
Doryteuthis sp.	X	--	--	--	--	--	--
Doryteuthis plei (Blainville)	--	--	X	--	--	--	--
Galiteuthis armata Joubin	--	--	--	--	--	--	X
Gonatus fabricii (Lichtenstein)	--	--	--	--	--	--	X
Heteroteuthis dispar (Ruppell)	--	--	--	--	--	--	X
Histioteuthis bonelliana (Ferussac)	--	--	--	--	--	--	X
Illex coindeti (Verany)	--	--	--	--	--	--	X
Illex illecebrosus coindetti (Verany)	--	X	X	--	--	--	--
Liocranchia reinhardti (Steenstrup)	--	--	--	--	--	--	X
Loligo sp.	X	--	X	--	X	--	--
Loligo pealei LeSueur	--	X	--	--	--	--	--
Loligo reynaudii d'Orbigny	--	--	X	--	X	X	X
Loligo vulgaris Lamarck	--	--	--	--	X	--	--
Lolliguncula brevis (Blainville)	--	X	--	X	--	--	--
Lolliguncula mercatoris Adam	--	--	X	--	--	--	--
Mastigoteuthis (?) sp.	--	--	--	--	--	--	X
Octopodoteuthis sicula (Ruppell)	--	--	X	--	X	X	--
Ommastrephidae	--	--	--	--	--	--	X
Ommastrephes pteropus Steenstrup	--	X	X	--	--	--	--
Ommastrephes sagittatus (Lamarck)	--	--	--	--	--	--	X
Onychoteuthis banksii (Leach)	--	--	X	--	--	--	X
Onykia appellofii Pfeffer	--	--	X	--	--	--	--
Phasmatotenthion richardi (Joubin)	--	--	--	--	--	--	X

Appendix Table 1.--Food found in stomachs of seven species of tuna from the Atlantic Ocean--Continued

FOOD ITEM	SPECIES OF TUNA						
	Euthynnus alletteratus	Katsuwonus pelamis	Thunnus albacares	Thunnus atlanticus	Thunnus thynnus	Thunnus obesus	Thunnus alalunga
INVERTEBRATES							
Sepia sp.	X	--	X	--	--	--	--
Sepietta oweniana d'Orbigny	--	--	--	--	--	--	X
Spirula spirula (Linnaeus)	--	--	X	--	X	X	X
Teuthoidea	X	X	X	X	X	--	--
Taoniinae	--	--	--	--	--	--	X
Taonidium pfefferi Russell	--	--	--	--	--	--	X
Teuthowenia (Heliocranchia) pfefferi (Massy)	--	--	--	--	--	--	X
Todaropsis eblanae (Ball)	--	--	X	--	--	--	X
GASTROPODA:							
Gastropoda (not further identified)	--	X	X	X	--	--	X
Janthina sp.	--	--	--	--	--	--	X
Janthina exigua Lamarck	--	--	--	--	--	--	X
HETEROPODA:							
Atlantidae	--	--	--	--	--	--	X
Atlanta sp.	--	--	X	X	--	--	--
Atlanta peronii LeSueur	--	--	--	--	--	--	X
Heteropoda (not further identified)	--	X	--	X	--	--	--
Pterotrachea sp.	--	--	X	--	X	X	X
PTEROPODA:							
Cavolinidae	--	--	X	--	X	--	X
Cavolinia sp.	--	--	X	--	X	X	X
Clio pyramidata Linnaeus	--	--	--	--	--	--	X
Creseis sp.	--	--	--	X	--	--	--
Cuvierina sp.	--	--	X	--	--	--	--
Diacria trispinosa (LeSueur)	--	--	--	--	--	--	X
Limacina sp.	--	--	--	X	--	--	--
Pteropoda (not further identified)	--	X	--	--	--	--	--
MISCELLANEOUS:							
Chelophyes appendiculatta (Eschschultz)	--	--	--	--	--	--	X
Galetta australis? (LeSueur)	--	--	--	--	--	--	X
Naiades cantrainii (Delle Chiaje)	--	--	--	--	--	--	X
Pelagia noctiluca Péron and LeSueur	--	--	--	--	--	--	X
Pyrosoma atlanticum (Péron)	--	--	--	--	--	--	X
Salpidae	--	--	X	--	X	X	X
Salpa (Iasis) zonaria Pallas	--	--	--	--	--	--	X
Torrea candida (Delle Chiaje)	--	--	--	--	--	--	X
Velella velella Linnaeus	--	--	--	--	--	--	X

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